Ground Node

Michael Hurley
Naval Research Laboratory Code 8213
Washington, DC 20375
phone: (202) 767-0528 fax: (202) 767-9339 email: mhurley@space.nrl.navy.mil

Randolph Nichols
Naval Research Laboratory Code 8110
Washington, DC 20375
phone: (202) 767-4671 fax: (202) 767-6611 email: randolph.nichols@nrl.navy.mil

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LONG-TERM GOALS

Rapid & Robust Deployment to Enable Localized Situational Awareness in Coastal Areas: Although designed for coastal use, the Ground Node system can be rapidly deployed anywhere with high availability. Typically the Ground Node will be deployed to areas with high maritime traffic. High automation and remote control are derived requirements to meet this goal.

Support Identifying Vessels Passing through Chokepoint Waterways: The combination of electronic and optical capabilities enables visual verification of inferences drawn from received signals. The multi-INT sensor suite, combined with close proximity, provides high quality data for local use as well as for national Maritime Domain Awareness databases.

Interoperability and Operationally Contributive: As common to all Nodes developed under the Space INP's Steady Lookout, the Ground Node is capable of collaborative operation with multiple Nodes possessing complementary capabilities, consistent with FORCEnet operations. This includes ground-to-ship and ground-to-air collaboration for geolocation and future data fusion applications. The Ground Node proved effective during previous experiments with platforms in the air and afloat. In addition to the specific contributions presented later in this paper, the Ground Node has also provided data to the Navy/Coast Guard vessel tracking program, AISLive.com, and is capable of operating with National sources. The Ground Node is a sub-task in a broader Space INP, "Steady Lookout" Task. The complete Steady Lookout is a multi-platform prototype working together to advance FORCEnet operations by bringing to bear the best characteristics of each platform to address Naval needs such as Communications-on-the-Move and Maritime Domain Awareness.

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14. ABSTRACT
Rapid & Robust Deployment to Enable Localized Situational Awareness in Coastal Areas: Although designed for coastal use, the Ground Node system can be rapidly deployed anywhere with high availability. Typically the Ground Node will be deployed to areas with high maritime traffic. High automation and remote control are derived requirements to meet this goal.

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General: Within ONR's Space INP, the "Steady Lookout" prototype emphasizes loosely integrating sensors based on the ground, in the air, at sea, and in space. Each sensor contributes what it's best suited to collect, process, and report, adding information to achieve a common maritime picture. Ground Node capabilities were built upon NRL's Multi-Sensor Suite (MSS) ES system resulting from ONR's vessel tracking program. The Ground Node possesses RF and optical collection capabilities. The electronic signal collection capabilities are all integrated into a Copperfield System, which was upgraded to Copperfield 2 under Steady Lookout. Copperfield 2 provides ELINT, COMINT, AIS, SEI, and Common Services. The Ground Node produces precision-timed data, direction finding of signals that operate in the microwave bands, rapid response and deployment, remote operation, and high-resolution-map displays. It was developed to provide local presence with high-quality, close-proximity collections, often including visual, high-resolution images of objects. The goal of these ground sites is to provide information about high-traffic shipping areas—areas of specific interest to the Navy. When they can be visually verified by a person or optically via imagery, the resulting correlation of a ship to its electronic emanations also serves as ground truth for national databases and other collections. The MSS has undergone multiple upgrades, sponsored by various organizations that needed specific, additional capabilities. Over the period of Ground Node development, Steady Lookout gained significant leverage from the funds provided by other sponsors. For example, the former Office of Force Transformation (OFT), now part of OSD's DDR&E/Operational Experimentation Office, provided funds to enable reporting of ES data to the Virtual Mission Operations Center, in conjunction with an aerostat-borne sensor suite, enabling the demonstration of the full Ground Node capabilities.

OBJECTIVES

Enable Precision Time Stamped Data Sharing: The Ground Node System uses GPS and a 10-MHz rubidium time standard to precisely measure and assign time to digitized signals collected. Collaborative experiments with the Sea Node System, with both Nodes using their own precision-timing subsystems, resulted in successful geolocations of radar signals.

Develop and Verify Geolocation Techniques and Algorithms Practical for Rapid Deployment: Given the leverage resulting from multiple sponsors of different capabilities integrated within the Ground Node System, all sponsors benefit from having available in one deployable system multiple capabilities that indicate the location of signals of interest. The Low-cost Direction Finding (DF) capability uses 'patch' antennas and phase processing to determine the relative angle from which a source is radiating. The Searchlight geolocator was developed and initially tested using early versions of the Ground Node System.

Use Active Signals and Passive Reception to Gain Maritime Awareness Within A Local Area: The Ground Node System uses active radar to track local vessels afloat. Data from this active tracking signal are fused with other data collected passively, i.e., radar signals, AIS reports, communications signals, and imagery, including that produced by an auto-tracking video camera.

Share Data Collected: Data from the Ground Node System are made available in various formats to users, depending on their preferences. For example, AIS contacts are reported directly to the Coast Guard R&D Center's coastal AIS network, which also feeds the Coast Guard's National AIS network. AIS and radar tracks are correlated as the track data are collected. In conjunction with the radar and AIS correlation, the Ground Node begins fusing Copperfield ELINT lines of bearings to a track if the

vessel is radiating its own radar. The characteristics of the target vessel's radar are fused to the track. In addition, as the track passes in view of the Ground Node's Optics subsystem, the Ground Node cues the imaging subsystem to capture images of the vessels and associate them to the track. The Ground Node provides fused data to VMOC and the Maritime Automated Supertrack Enhance Reporting (MASTER) JCTD now transitioned to ONI.

Compatibility with Other Nodes Having Similar or Complementary Capabilities: The Ground Node has worked cooperatively with TacSat-2 in space and with the Sea Node System afloat. In both cases, data formats were coordinated and data were shared during successful experimentation. The Ground Node also demonstrated inter-operable formats, including a CTOA-data format produced prior to the Steady Lookout 07 Experiment and the more standard Airborne Overhead Interoperability Office (AOIO) format.

APPROACH

The approach used to evolve the Ground Node System has been to focus on incrementally adding capabilities to the system and ensuring via testing that each new capability becomes part of the integrated whole. In 2006, the system took an evolutionary jump by engineering the core functions into the Copperfield system, which enables modular integration of additional functions within a common architecture. This reduced the size, weight, and power requirements, adding to the Ground Node's portability and affordability. To date, the full Ground Node System comprises only two full racks of equipment that provide the full functionality described in this paper. All capabilities were integrated into a trailer system with the capability of raising the sensors 80 feet high in up to 70 knot winds, significantly expanding the electronic and visual horizon. The Ground Node can accept site power but also comes with its own generator. Operations are performed remotely and are highly automated. This year's efforts leveraged 10 years of development. The primary developmental efforts were sponsored by Navy TENCAP, with the previously mentioned additional development funded by OSD's DDR&E/Operational Experimentation Office. Interest in using Ground Node capabilities has been expressed by the Navy, Air Force, DHS (i.e., Coast Guard, Customs/Border Patrol) and the National Park Service (NPS).

Key Personnel:

Randolph Nichols, Ground Node Program Manager, NRL 8110

Tom Pickard, Lead Optics and External Communications Engineer, NRL 8122

Tan Tran, Data Dissemination Lead and Web Interface Software Lead, NRL 8122

Brian Micek, Copperfield Software Developer, Micek Consulting

Josh May, Copperfield and ELINT Interface Software Developer, Sensor Software Incorporated

Bob Gettel, Lead Software Engineer, Sensor Software Incorporated

Ken Wilson, Lead Systems Engineer, Wilmark & Associates

Robert Lewis, Lead Ground Node Technician, Wilmark & Associates

William Spencer, Ground Node Technician, Wilmark & Associates

John Hoover, Lead Low Cost DF Developer, On Target Enterprise

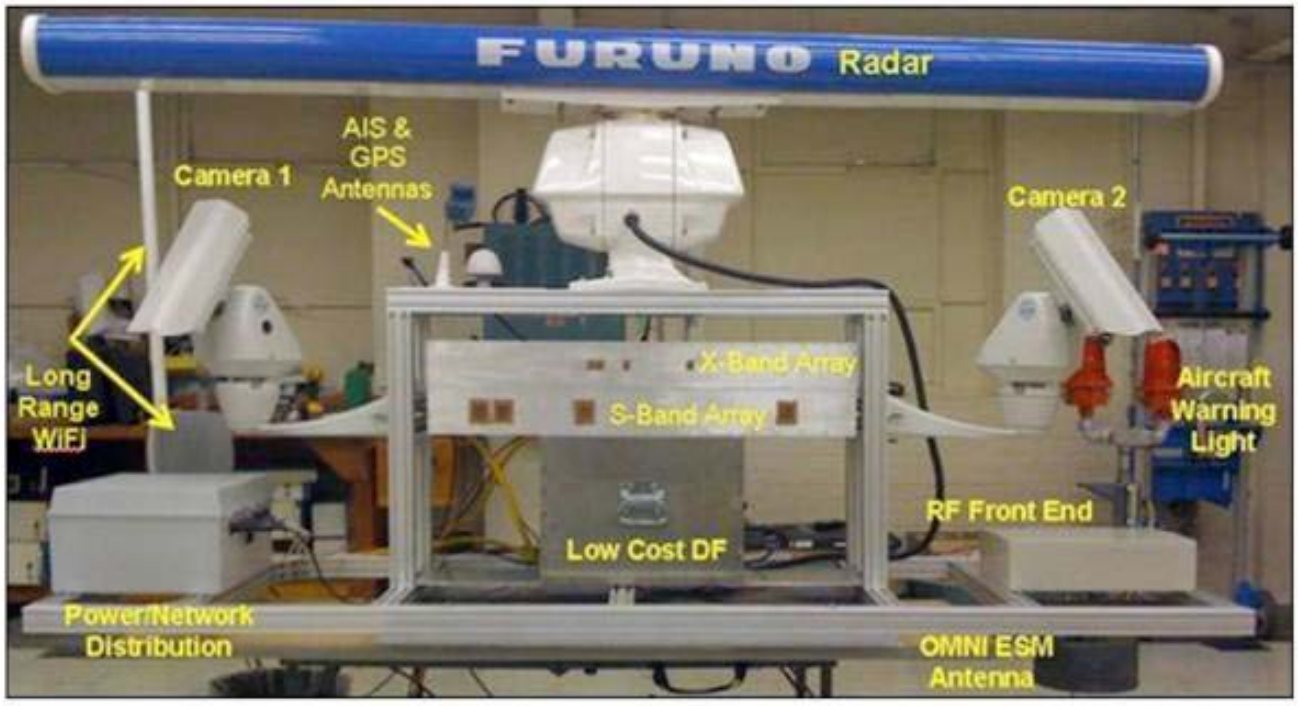
Ben Udall, Lead Hardware and Software Engineer Low Cost DF, On Target Enterprise

WORK COMPLETED

Having received the trailer and tower in late FY08, system development efforts in FY09 focused on installing and integrating the Ground Node capabilities with the mobile-ready platform.

Also in late FY08, plans had just changed with regard Ground Node deployment. Original plans were to deploy directly to Fort Jefferson on Dry Tortugas (near Key West, FL). Current plans are to initially deploy to the USCG Station on Ismoralda Key for training operations; then deploy at a to-be-determined date to Fort Jefferson on Dry Tortugas.

During FY09, NRL installed the electronic equipment bays and power-distribution system into the trailer, designed, installed, and tested the mast-head assembly to carry all requisite antennas and optical equipment, and integrated all Ground Node capabilities within the deployable enclosure. No unique towing vehicles are required for the enclosure. Details of equipment carried on the mast head are depicted in the Figure below.



The integrated tower can lift 2,500 lbs up to 80 feet high and survive 70-knot winds, significantly expanding the electronic and visual horizon. An integrated power generator enables autonomous, remote operation. Final testing of all Ground Node capabilities was completed just prior to releasing this paper. The Figure below depicts the completed Ground Node with the 80-foot mast in the stowed position.

Throughout FY09, deployment of the Ground Node was worked in detail with the Coast Guard. The Navy will receive the benefits of the data collection without the logistics burden of operations which the USCG has agreed to perform. The USCG in turn receives the benefit of the Ground Node capabilities. NRL has prepared to train the USCG operators when the capability is delivered at Ismoralda Key, shown in the left side of the Figure below. The right side of the Figure shows Fort Jefferson at Dry Tortugas.

NRL expects to deliver the Ground Node to Ismoralda Key in October 2009.

FY09 continued the third year of providing Ground Node data to other organizations. Recipients now include the National R&D Center (AIS data), National AIS Network, the Caribbean Air Maritime Ops Center (CAMOC) (fused data), and US Coast Guard Sector San Juan. MASTER JCTD, now transitioned to ONI, also implemented and tested the capability to receive Ground Node.

RESULTS

Ground Node development and testing are complete. All capability requirements have been met. The Ground Node system is ready to deploy in early FY10.

Interoperability: The Ground Node System's interoperability is considered when adding each incremental capability; its Track Fusion Processor (TFP) accepts and displays data from multiple sources. Current operations include accepting reports from Puerto Rico and providing data to users. Those users include subscribers to the VMOC Spydr, which was adopted in its unclassified form under sponsorship from the Shipboard AIS and Radar Contact Reporting (SARCR) program, which also uses the Ground Node System. Previous interoperability was proved from experimentation that shared data in AOIO-compliant format and during Steady Lookout 07, when data were shared to conduct experiments with the Sea Node System and geolocating radars via the Searchlight method. These current and previous efforts to achieve interoperability have been effectively integrated in the deployable system produced in FY09.

IMPACT/APPLICATIONS

As the value of data produced by the Ground Node System becomes apparent from operations at Ismoralda Key and Fort Jefferson, NRL expects it to be in ever-increasing demand for determining local awareness in many coastal areas as well as for improving national databases.

TRANSITIONS

The Ground Node prototype shown above will be transitioned into full operations in FY10. The USCG has agreed to assume responsibility for operations and to send the data collected into USCG and Navy systems allowing both local and national use.

The Ground Node has been considered for use in the Navy's MDA program. However the major changes in the funding of the Navy MDA spiral roll-out has delayed Ground Node's inclusion in the early MDA spirals.

The DHS has funded a system derived from the Ground Node called the Shipboard AIS and Radar Contact Reporting (SARCR) System to support JIATF-S in detecting "dark (non-radiating) targets."

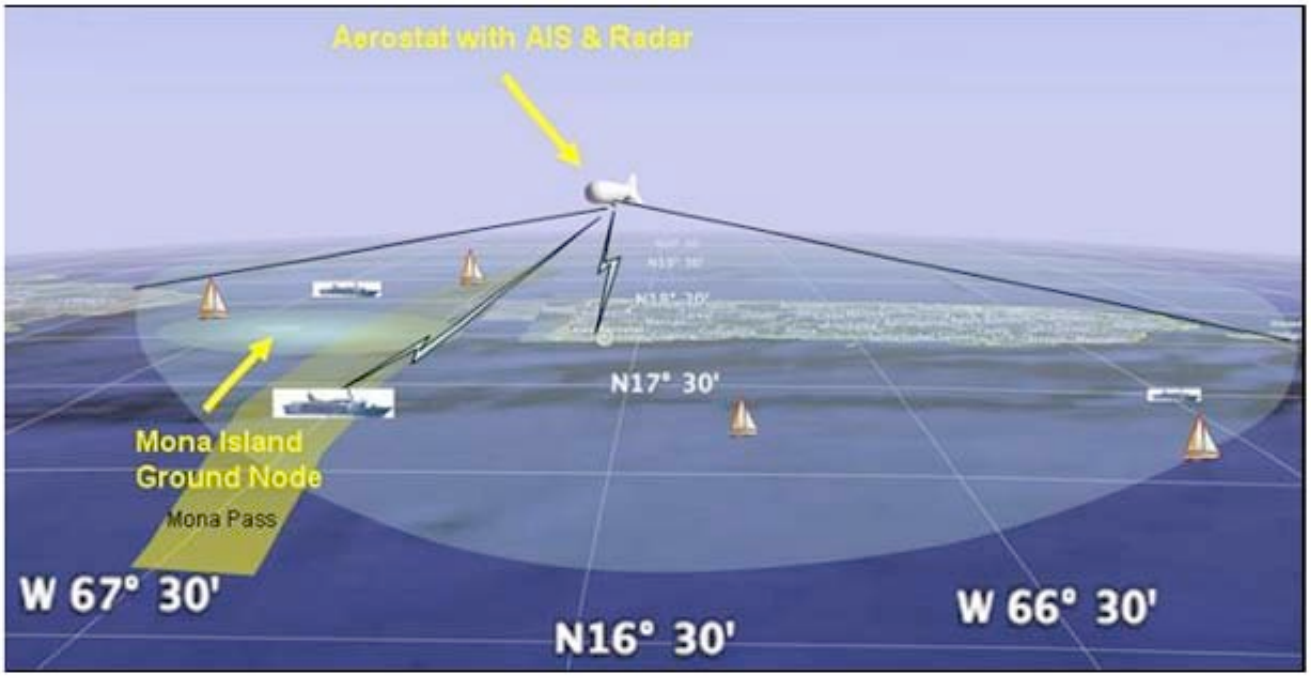
The Searchlight geolocator, developed first using the Ground Node System, has been adopted and furthered by the Sea Node System for geolocation; that system is poised for participation in ONR's Rapid Technology Transition (RTT) program.

Customs and Border Patrol have also asked the Coast Guard for permission to use the Ground Node in Miami to support their efforts for Super Bowl XLIV (February 7, 2010).

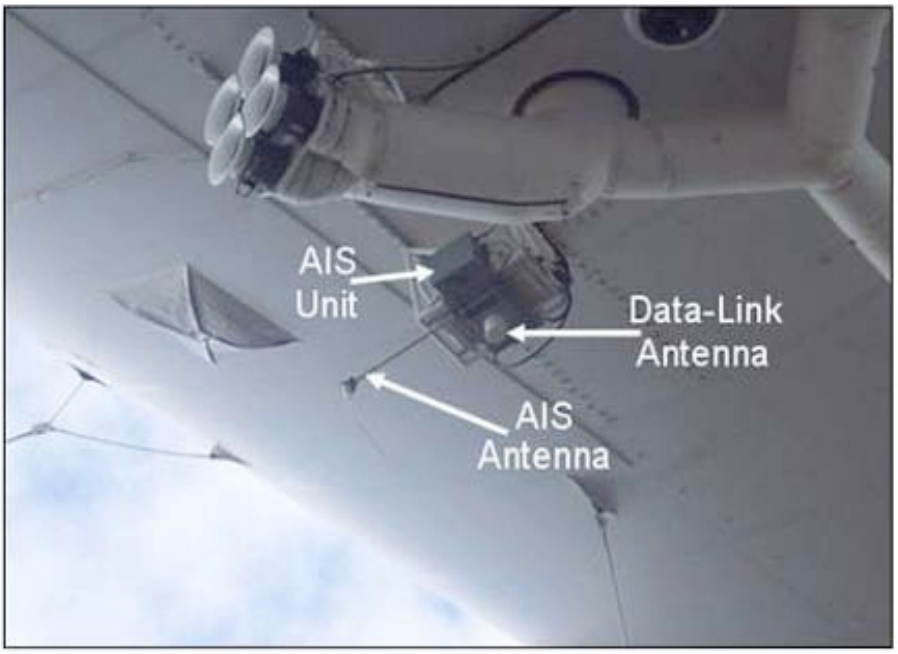
RELATED PROJECTS

Projects closely related to the Ground Node include the Vessel Tracking Program (VTP) Modular Sensor System, Project Spotlight, and Shipboard AIS and Radar Contact Reporting system.

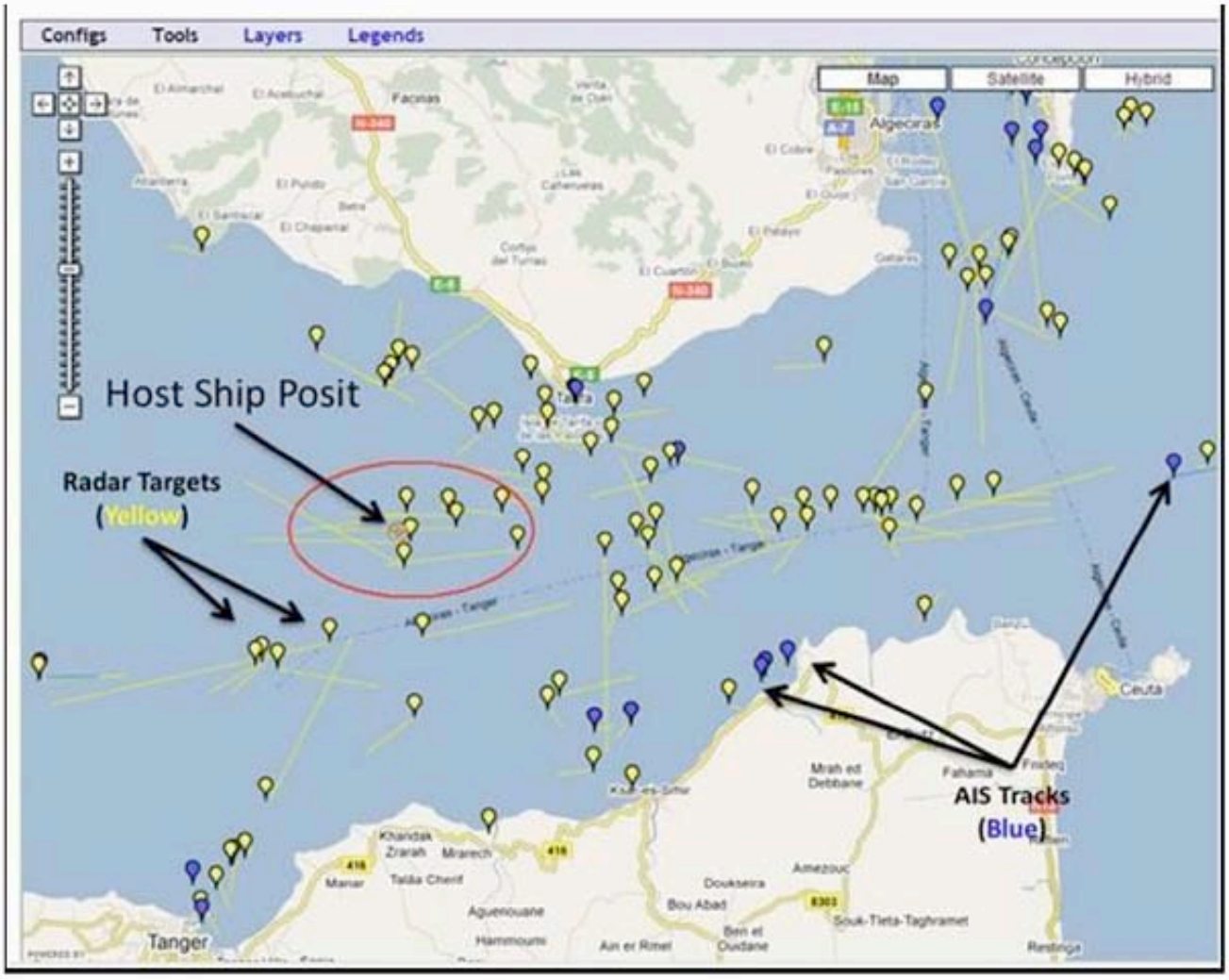
As part of “Spotlight” for OSD, NRL deployed to Puerto Rico an aerostat-borne radar and AIS receiver, which have been operating there since November 2006. The Figure below depicts the operating area.



That system continues to distribute live AIS data from Puerto Rico to NRL’s Chesapeake Bay Detachment (CBD), near Chesapeake Beach, MD, which forwards the data to National AIS databases**.** The radar data from the Aerostat is also still being collected, fused, and distributed to Caribbean Air Maritime Operations Center, Puerto Rico, and the US Coast Guard Sector San Juan. NRL has provided to the site manager at Lajas, PR site documentation to enable Air Force personnel to maintain the system. The Figure below shows the AIS unit that NRL installed on the aerostat. The aerostat is part of the Air Force Combat Command’s Counter Narcotics fleet under the AFCC’s Tethered Aerostat Radar Systems (TARS) Program. This Spotlight project leveraged and tested several Ground Node components and software elements.



Separately, capabilities of the Ground Node System have been accepted into the Shipboard AIS and Radar Contact Reporting (SARCR) System, which is funded by DHS to support efforts by JIATF-S to detect “Dark Targets” (non-radiating targets) and support counter piracy efforts. Another project objective is to collect commercial radar. DHS expects to build and install 15 units onto commercial ships and report data via Iridium. The Figure below depicts SARCR data as the host vessel exited the Mediterranean Sea through the Straits of Gibraltar in August 09.



PATENTS

NRL has a patent pending for the Searchlight geolocation method.